

Evaluation of missing canals in endodontically treated molar teeth in a Turkish population among age groups

Missing canals in molars among age groups

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Abstract

Aim: Root canal localization is necessary for proper canal disinfection and obturation. This study aimed to examine the missing canals in terms of aging in endodontically treated 1st and 2nd molars in a Turkish subpopulation.

Material and Methods: The study included maxillary and mandibular molar teeth of 619 subjects (317 female and 302 male). Cone-beam computed tomography images of 490 molar teeth representing at least one missing canal were divided into 3 groups according to the age of the subjects: 18–44, 45–64, and more than 65. The data were evaluated with the chi-square test, with the significance level set at a p-value of 0.05.

Results: The incidence of missing 2nd mesiobuccal canals in the 18–44 age group and 1st mesiobuccal canals in the 45–64 and over 65 age groups were statistically higher than in the other age groups ($p < 0.05$). The incidence of missing 2nd mesiobuccal canals in maxillary 1st molars was statistically higher than in maxillary 2nd molars ($p < 0.05$). There was no statistical difference between the types of missing canals and age groups in mandibular molars ($p = 0.772$).

Discussion: Missing canals were more frequent in the mesial roots of mandibular molars with aging. With age, the incidence of missing canals increased in maxillary first molars but decreased in maxillary second molars.

Keywords

Aging, Cone-Beam Computed Tomography, Geriatric Dentistry, Missed Canal

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Introduction

Knowing the morphology of the root canal system enhances the success of endodontic treatment [1]. Root canal localization is necessary for proper canal disinfection and obturation. The prognosis of teeth deteriorates as a result of operational mistakes that limit the management of intracanal infections [2]. Missing canals may act as a microorganism repository in failed endodontically treated teeth because the presence of unprepared regions in the root canals might lead to periapical lesions [3].

Failure to localize the root canal orifices is a common iatrogenic error [4]. The second mesiobuccal canals of maxillary first molars present the highest risk of missing during endodontic treatment among all root canals [5]. Detecting the presence of all canals in the tooth requires proper radiography. However, traditional dental radiography is often not sufficient, as it provides only a two-dimensional view. Cone-beam computed tomography (CBCT) compensates for this disadvantage by providing three-dimensional imaging of teeth with high resolution [6]. Calcification, which reduces the pulpal space dimension and narrows the root canals, is the most common of all age-related changes in teeth [7]. Dental treatments are more challenging for elders because of their medical risks, psychological limitations, and physical disabilities. As a result, access cavity preparation and root canal localization are quite difficult in the elders [8].

This study aimed to evaluate the frequency of missing canals in endodontically treated 1st and 2nd molars of a Turkish subpopulation in terms of age. The null hypothesis of the current study was that advancing age would affect the incidence of missing canals in molars.

Material and Methods

The local ethics committee accepted approved the study protocol (Decision No. 2022/292, Decision Date: 2022-10-26). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. CBCT images of 619 (317 female, 302 male) subjects who underwent root canal procedures within the previous 5 years were retrospectively collected from the archive of a private dental clinic. CBCT images of 913 molars that underwent root canal treatment were examined. CBCT images of 490 1st and 2nd molars with at least one missing canal were included in the study. The number of evaluated teeth was 224 maxillary 1st molars, 75 mandibular 1st molars, 127 maxillary 2nd molars, and 64 mandibular 2nd molars.

All CBCT examinations were performed for clinical diagnosis, apart from the current study. CBCT images were captured with the Orthophos XG 3D (Sirona Dental System, Charlotte, North Carolina, USA) by using the same setting. CBCT images were processed using a software imaging tool (Sirona Galaxis Galileos Viewer Version 1.9.2, Sirona Dental Systems GmbH, Bensheim, Germany) in a dark environment. An LCD monitor (HP Compaq LE2002x, HP, TX, US) with a resolution of 2560 x 1600 pixels was used for visualization. CBCT images with poor quality and artifacts were also eliminated. Two endodontists

with at least ten years of CBCT imaging experience investigated images between October and December 2022. In the event of a disagreement, they re-analyzed the images to reach a final decision. For each molar tooth, the following information was recorded: the gender and age of the participant, the number of the tooth, and the localization of the missed canals. Missed canals were recorded as first mesiobuccal (MB1), second mesiobuccal (MB2), distobuccal (DB), palatal (P) for maxillary molars, and mesiobuccal (MB), middle mesial (MM), mesiolingual (ML), distobuccal (DB), and distolingual (DL) for mandibular molars. The personal data of the participants was kept secret. Missing canals were classified as those with no indication of filling material from the canal's coronal orifice to the apex.

The presence of missing canals was initially assessed on axial slices and then verified on other planes. The teeth included in the study were divided into 3 groups according to the age of the subjects: 18-44 (n = 140), 45-64 (n = 248), and more than 65 (n = 102).

Statistical analysis

The data were evaluated with a statistical software tool for Windows (SPSS V25; IBM, Chicago, IL). The standard descriptive methods were applied to determine the characteristics of the sample. The chi-square test was used to compare the categorical demographic variables among the groups. The confidence interval was set to 95% and p < 0.05 was considered statistically significant.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

A statistically significant difference was determined between the types of missing canals detected in maxillary 1st and 2nd molars and age groups (p<0.05) (Table 1).

The incidence of missing MB2 canals in the 18-44 age group and MB1 canals in the 45-64 and ≥65 age groups were statistically higher than in the other age groups (p<0.05). However, no

Table 1. Distribution of missing canals in maxillary molars by age groups.

Type of missing canal	Age groups			Total n	χ ²	P
	18-44 n (%)	45-64 n (%)	≥65 n (%)			
2 nd mesiobuccal	90 (87.38) ^a	124 (70.06) ^b	41 (57.75) ^b	255	21.29	0.002*
Palatal	1 (0.97) ^c	2 (1.13) ^c	1 (1.41) ^c	4		
1 st mesiobuccal	3 (2.91) ^d	24 (13.56) ^e	14 (19.72) ^e	41		
Distobuccal	9 (8.74) ^f	27 (15.25) ^f	15 (21.13) ^f	51		

*p<0.05; Chi-square test. ^{a, b, c, d, e, f} Different lower case superscript letters in the same line show a statistically significant difference between groups.

Table 2. Distribution of missing canals in the maxillary molars.

Type of missing canal	Maxillary 1 st molar	Maxillary 2 nd molar	χ ²	P
	n (%)	n (%)		
2 nd mesiobuccal	182 (81.3) ^a	73 (57.5) ^b	34.929	0.001*
Palatal	2 (0.9) ^c	2 (1.6) ^c		
1 st mesiobuccal	22 (9.8) ^d	19 (15) ^d		
Distobuccal	18 (8) ^e	33 (26) ^f		

*p<0.05; Chi-square test. ^{a, b, c, d, e, f} Different lower case superscript letters in the same line show statistically significant difference between groups. (Chi-square test).

Table 3. Distribution of missing canals in the mandibular molars.

Type of missing canal	Mandibular 1 st molar n (%)	Mandibular 2 nd molar n (%)	χ^2	P
Mesiobuccal	7 (9.3) ^a	18 (28.1) ^b		
Middle mesial	27 (36) ^c	3 (4.7) ^d		
Distolingual	21 (28) ^e	9 (14.1) ^f	38.292	0.001*
Distobuccal	8 (10.7) ^g	4 (6.3) ^h		
Mesiolingual	12 (16) ^b	30 (46.8) ^r		

* $p < 0.05$; Chi-square test, ^{a,b,c,d,e,f,g,h,r} Different lower case superscript letters in the same line show a statistically significant difference between groups. (Chi-square test).

statistically significant difference was found between the types of missing canals detected in mandibular 1st and 2nd molars and age groups ($p=0.772$).

The incidence of missing MB2 canals in maxillary 1st molars was statistically higher than in maxillary 2nd molars ($p < 0.05$). The incidence of missing DB canals in maxillary 2nd molars was statistically higher than in maxillary 1st molars ($p < 0.05$) (Table 2).

The incidence of the missing MB canals in mandibular 2nd molars was statistically higher than in mandibular 1st molars ($p < 0.05$) (Table 3).

The incidence of missing MM and DL canals in mandibular 1st molars was higher than in mandibular 2nd molars ($p < 0.05$). The incidence of missing ML canals in mandibular 2nd molars was higher than in mandibular 1st molars ($p < 0.05$). In the study, the most common type of missing canals was the MB2 canals in maxillary 1st molars ($n = 182$, 81.3%), and the least common type was the P canals in maxillary 1st molars ($n = 2$, 1.6%) (Table 2).

Discussion

Missing canals are not the only cause of apical pathologies, but the inability to treat the entire root canal system is one of the leading factors [1]. Untreated canals accounted for 3–8.8% of endodontic failures [9]. Conventional radiographs used in assessing the existence of canals provide information based on a two-dimensional image of three-dimensional anatomy [6]. However, angled periapical radiographs can provide more information about canal localization. CBCT is more efficient than periapical radiographs in detecting root canals and displays more anatomical variation than panoramic radiographs [10]. On the other hand, CBCT is not often used for endodontic procedures as it generates a higher radiation dose than other methods. The literature suggests magnification, enhanced illumination, and the use of special burs or ultrasonic tips for the detection of the canals [10,11]. However, the widespread use of these methods may not provide reliable detection of all existing canals [12].

The overall frequency of missed canals among endodontically treated teeth ranged from 12% to 23.04% in studies using CBCT [13,14]. The maxillary 1st molars had the largest proportion of untreated root canals, ranging from 44.2 % to 59.0 % [13,15]. Also, the MB2 canal of the maxillary 1st molar had the highest incidence with 73.8% (from 48.0% to 97.6%) [16]. These findings were consistent with our findings, which

found that maxillary 1st molars had the highest incidence of untreated canals, followed by maxillary 2nd molars, and MB2 was the most common type of missing canal. Our results also showed that the order of undetected canals in maxillary molars from the highest to the lowest was MB2, DB, MB1, and P, respectively, which was the same as in a previous study [5]. The anatomy of the mesiobuccal root of maxillary molars is more complicated than that of other roots, which might be the primary explanation. Also, the maxillary 1st molars have been in the oral cavity longer than the other teeth and are therefore the most commonly treated teeth. Finally, it is difficult to reach the pulp chambers of maxillary molars due to their location in the oral cavity. Connecting the canals to the pulp chamber at a more horizontal angle may complicate the placement of the canal orifices. The incidence of a missing DB canal in maxillary 2nd molars in the study was statistically higher than in maxillary 1st molars. In maxillary second molars with three canals, the tendency of DB canals to be close to MB canals mesially may make it difficult to detect the orifice of the canals.

Similar to the study by Costa et al., we found that ML is the most common untreated canal in mandibular molars. The most commonly missed canal of the mandibular 1st molar was MM [15]. Contrary to our study, Nascimento et al. reported that the DB canal was the most frequently unfilled canal type in mandibular molars. Also, that study did not report any missed MM and DL canals [17]. However, in our study, DL canals were the second most common type of missing canal. These differences may be related to the sample sizes of the studies. The current study, which examined 490 root-filled teeth, has a narrower data range compared to other studies [13,15,17]. Our study retrospectively examined CBCTs taken for different reasons, not just for endodontic purposes. This may have resulted in a lower -than -expected incidence of missing canals. Also, there were no records kept on factors that may impact the study's outcome, such as the canal preparation and irrigation method utilized, as well as the clinicians' qualifications and experience. The goal of this study was to find out how the likely disadvantages that come with age affect the number of missing canals in endodontically treated teeth in older people. According to the World Health Organization, one out of every eleven people was classified as old in 2019, and one out of every six will be old within 30 years (available at: <https://www.un.org>).

In all age groups in the study, the most common type of missing canal in the maxilla was MB2, and the least common type was P. In the 18–44 age group, the second most frequently missed canal type was DB. In the over-65 age group, the most common missing canals in maxillary 1st and 2nd molars were MB2 (57.75%), DB (21.13%), and MB1 (19.72%), respectively. A statistically significant difference was determined between the types of missing canals detected in maxillary 1st and 2nd molars and age groups ($p < 0.05$). The incidence of the missing MB2 canal in the 18–44 age group, and the missing MB1 canal in the 45–64 and over-65 age groups were statistically higher than in the other age groups. The increase in the incidence of missing canals may be associated with increasing dentin thickness with aging. The secondary dentin of impacted teeth significantly increases after the age of 39 [18]. Although there

was no statistical difference, the incidence of missing MB2 decreased while the incidence of missing MB1 and the DB canal increased with aging. The pulpal calcifications caused by aging may have caused the MB2 canals, which have a small volume compared to other canals, to narrow and completely occlude. Also, age-related health problems make clinical applications difficult and may cause missed MB1 and DB canals with larger pulpal volumes.

Our results showed that in the mandibular molars of elders, the missing canal types were ML, MM, MB, DL, and DB, in order from highest to lowest. Elders were also more likely to have missing canals in their mandibular molars, especially in the canals in the mesial root. When all age groups were evaluated together, the number of MB, MM, and ML missing canals rose up as people got older. Although no statistical correlation was found, a percentage increase was observed with age. However, the incidence of a missing DL canal in the distal root decreased with age. The fact that dentin thickness increases with age could help explain this finding [7]. The over-40 age group has narrower root canals than others [19]. The narrowing of the pulp chamber of mandibular molars due to aging is more in the mesial direction than in the distal direction. There is a significant difference between age groups in the increase in dentin thickness of the mesial roots but no difference in the distal root [7]. Similarly, dentin thickness in the MB and ML canals increases significantly with age [20]. The high rate of missed canals in the mesial roots of endodontically treated mandibular 1st molars may also be related to the anatomical variability of the mesial root. Research on the direction of calcification produced by age-related changes in the pulp is necessary to explain the difference between the mesial and distal roots of mandibular molars.

The order of the percentiles of missing canal types in the maxillary molars was the same between the elderly and young individuals, defined as those aged 18 to 44. The mandibular molars, however, had a quite distinct pattern. The most common types of missing canals in mandibular molars of the elders were ML, MM, MB, DL, and DB, in descending order from most to least, while in young adults they were DL, ML, MM, MB, and DB. In addition, as the age of the groups increased, the incidence of missing canals in the 1st molars increased, but the incidence of missing canals in the 2nd molars decreased without statistical significance. To our knowledge, this finding has not been previously reported in the literature. This may be related to age-related histological changes in the teeth. With age, the number of blood vessels in the pulp diminishes, the arterioles thicken, and the vessel lumens narrow. As a result, regardless of the extent of pulp calcification, the vascularity of the pulp declines [21]. Caries, periodontal problems, occlusal attrition, and prosthetic and restorative applications may also exacerbate age-related changes in the pulpal space [22]. Root canal localization is nearly three times more difficult in older people than in younger ones [8], because age-related calcifications in the pulp develop only in the coronal third of the root [23]. However, this situation does not affect working length determination, instrumentation, or canal obturation [8].

Limitation

One of the limitations of the study was that elders were

defined as people who were 65 years of age or older. Although there is no universally accepted aging limit, the World Health Organization considers individuals aged 65 and up to be old, and those aged 85 and up to be very old. Another limitation of the current study was that patients' systemic health problems were not recorded. Besides, no data was obtained about the devices used by dentists for magnification, illumination or preparation of cavity walls to determine the location of the canals during endodontic procedures. In addition, no records were kept regarding the educational status and experience of the dentists performing root canal treatment. Future studies in which such information will be obtained will bring a different perspective in evaluating the etiology of missing canal.

Conclusion

Within the limits of this study, missing canals were found more often in the mesial root of mandibular molars as people aged. The number of missing canals in maxillary 1st molars increased with age but decreased in maxillary 2nd molars. A procedure error such as like a missed canal is more likely to happen in older people, so every precaution should be taken.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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